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ABSTRACT

Detecting Structural Breaks in Exchange Rates in Transition Economies*

The aim of this Paper is to provide evidence of structural breaks in the exchange rates of European transition economies. The Vogelsang (1997) testing procedure is used. The technique allows for the detection of a break at an unknown date in the trend function of a dynamic univariate time series and does not impose restrictions on the nature of data. In many cases the detected breaks appear to be linked with policy measures adopted at the same time. In several cases the trend break coincided with a marked change in economic development. In others no break was detected. The results seem to depend on the economic climate of a particular country.

JEL Classification: C20, F30, P52
Keywords: exchange rate, monetary policy, structural change and transition

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NON-TECHNICAL SUMMARY

The issue of the trend behaviour of exchange rates has been widely discussed in recent literature. This Paper departs from much of the mainstream literature in two ways. While the primary focus will be on finding break dates in the trend behaviour of exchange rates of 11 Central and Eastern European (CEE) countries, the analysis will not be associated with questioning broken trend stationarity. Instead, endogenously determined break dates will be linked with one-time shocks altering trend functions of exchange rates. A statistically significant break in the trend function of the exchange rate will thus define an important change in its behaviour

An exchange rate and its regime are important elements in the overall monetary policy of each country. The question of whether a structural break occurred in the exchange rate evolution is of special interest. Determining the source of the break is notably important in the case of transition economies because international lending institutions like the International Monetary Fund, the World Bank, and the European Bank for Reconstruction and Development (EBRD) provide credit for countries based on their macroeconomic stability and a stable exchange rate. This is true no matter what kind of regime is adopted.

The aim of this Paper is to provide evidence of the existence or non-existence of structural breaks in exchange rate series during transition. I will use a rigorous testing procedure to answer the following questions: (1) whether there was a break or not, and if yes, when it occurred; and (2) whether a break coincides with an administrative step associated with an exchange rate or its regime. In doing so, we will attempt to shed some light on the trend behaviour of exchange rates during transition.

The breaks in this Paper are determined using the testing procedure devised by Vogelsang (1997). The test allows detection of a break at an unknown date in the trend function of a dynamic univariate time series. The advantage of the procedure is that it does not impose restrictions on the nature of data since it allows for unit-root in the errors and can be applied to regressors that are functions of time.

The study uses data from the following 11 countries: the Czech Republic, Hungary, Poland, Slovakia, Slovenia, Albania, Bulgaria, Romania, Estonia, Latvia and Lithuania. The time span of the data is from January 1991 to December 1999. The monthly average exchange rates of respective national currencies were obtained from the International Monetary Fund's International Financial Statistics, the Bank for International Settlements and the EBRD. The reports of the national banks of each country in question were consulted as well.

The main outcomes of the analysis are that a) we were frequently able to reject the null hypothesis of no structural break, and b) numerous detected breaks could be associated with policy measures adopted at the same time. However, in several cases we were not able to associate the trend break with a coinciding policy measure that would have a sufficient impact on the exchange rate, its regime, or the foreign exchange market environment.

In Central European countries the exchange rates evolved in a relatively stable manner without extremely volatile periods or extreme depreciation. Poland was the only country where we were not able to reject the null hypothesis of no structural break. Most of the detected structural breaks could be associated with policy steps. However, in the cases of the Czech Republic and Slovakia we found that the breaks occurred prior to policy steps aiming to influence the exchange rate evolution. In these instances the policy steps have been an acknowledgement of the structural change that had already happened due to an economic development.

Serious structural breaks were found in the group of Balkan countries that includes Albania, Bulgaria and Romania. In this group the structural breaks can be decisively associated with policy steps that either affected the exchange rate, its regime, the foreign exchange market environment, or a combination of these. In Albania the structural break was entirely associated with the massive devaluation of the exchange rate and a revision of its regime. In Romania and Bulgaria the break was associated with monetary policy steps related to foreign exchange markets that were accompanied by massive devaluation.

A series of events belonging to overall monetary reforms paired with alterations of the exchange rate regime formed the complex environment that affected the trend behaviour of the exchange rates in the group of Baltic states (Estonia, Latvia and Lithuania). These countries freed themselves from the former Soviet Union and within the scope of monetary reforms re-introduced their national currencies. The structural breaks detected were associated mainly with the re-introduction of national currencies and adoption of tight exchange rate regimes. Those countries that pegged their currencies to the US dollar or the Deutsche mark experienced a trend break in the exchange rate denominated in a currency other than that of the peg. Such a finding is consistent with world macroeconomic development, as it is associated with the gradual appreciation of the US dollar against the Deutsche mark since the fall of 1996.

1. Introduction and Motivation

The issue of the trend behavior of exchange rates has been widely discussed in recent literature. This paper departs from much of the mainstream literature in two ways. While the primary focus will be on finding break dates in the trend behavior of exchange rates of eleven Central and Eastern European (CEE) countries, the analysis will not be associated with questioning broken trend stationarity. Instead, endogenously determined break dates will be linked with one-time shocks altering trend functions of exchange rates. A statistically significant break in the trend function of the exchange rate will thus define an important change in its behavior.

An exchange rate and its regime are important elements in the overall monetary policy of each country. The question of whether a structural break occurred in the exchange rate evolution is of special interest. Determining the source of the break is notably important in the case of transition economies because international lending institutions like the International Monetary Fund, the World Bank, and European Bank for Reconstruction and Development (EBRD) provide credit to countries based on their macroeconomic stability and a stable exchange rate. This is true no matter what kind of regime is adopted.

Any country in transition must undergo a stage of macroeconomic stabilization, which is inevitably accompanied by large shocks to macroeconomic fundamentals and numerous policy measures adopted to cope with such shocks. The nature and magnitude of these shocks and reforms affect the progress of economic development. Owing to the relative openness and the close economic relations between transition economies in Central and Eastern Europe and between these countries and the European Union, the trend behavior of the exchange rate and the exchange rate regime play an important role in the movement of the CEE countries towards sustainable growth.

The trend behavior of exchange rates has attracted research interest associated with questioning the validity of purchasing power parity. Such an approach can be found in Hegwood and Papell (1998), Wu (1997), Culver and Papell (1995), and Flynn and Boucher (1993) among others. The majority of the previous research has found significant estimates of the break parameters. When the break points or margins of

structural instability are taken into account, most of the exchange rates could be modeled as stationary around a broken trend.[1]

With respect to the question of the broken trend, Stock and Watson (1996) have recently provided ample evidence that a large set of macroeconomic variables is subject to structural instability. Exchange rates might be affected by one-time shocks generated by structural changes in the underlying economies and/or measures taken by policy-making authorities. During the transition process many crucial steps performed by authorities are likely to either cause or aid in bringing a kind of structural change. A change in an exchange rate regime and/or the official adjustment of an exchange rate level might be mirrored by a structural break in the evolution of an exchange rate.

The aim of this paper is to provide evidence of the existence or non-existence of structural breaks in exchange rate series during transition. I will use a rigorous testing procedure to answer the following questions: (1) whether there was a break or not, and if yes, when it occurred; and (2) whether a break coincides with an administrative step associated with an exchange rate or its regime. In doing so, I will attempt to shed some light on the trend behavior of exchange rates during transition. I do not intend to draw conclusions regarding the performance of national banks in transition countries. The monetary policy executed by any national bank is too complex to be considered within the scope of this paper. With respect to changes in the trend behavior of exchange rates, I will focus only on a subset of these actions aiming directly at the exchange rate, its regime, or at the foreign exchange market environment.

In this paper I also try to identify an institutional act as a possible cause of a change in trend behavior. The market usually anticipates any institutional act, since it is discussed at the policy-making level prior to the time when it is enacted. Information contained in the discussions is then, in its discounted version, transposed to affect the actions of various market players. Thus, the effect of the step taken by the authority that is *not sudden* is likely to be suppressed because of anticipations and expectations. Only a truly *sudden* act may result into a change in trend behavior. We expect that, for example, a sudden devaluation would have such an effect. However, it should not come as a surprise that estimated break dates might differ from real world events that might cause a

[1] We do not associate our research of the trend behavior of exchange rates of the CEE countries with questioning the validity of purchasing power parity.

structural change. On other hand, the underlying economic development may cause a structural change with policy step lagging way behind.

The breaks in this paper are determined using the testing procedure devised by Vogelsang (1997). The test allows detection of a break at an unknown date in the trend function of a dynamic univariate time series.[2] The advantage of the procedure is that it does not impose restrictions on the nature of data since it allows for unit-root in the errors and can be applied to regressors that are functions of time.[3]

The rest of the paper is organized as follows. Section 2 formally presents the testing procedure used. Section 3 describes the data including their basic statistics. Section 4 brings forth empirical findings and is then followed by a brief conclusion.

2. Technique to Detect Structural Breaks

In order to detect trend breaks in the data we use the Wald-type test suggested by Vogelsang (1997). We adhere to the original notation of the testing procedure that considers the following data-generating process for a univariate time series process, $\{y_t\}_1^T$, with a break in trend at unknown time T_b^c,

$$y_t = f(t)\theta + g(t,T_b^c)\gamma + \upsilon_t, \quad (1)$$

$$A(L)\upsilon_t = e_t, \quad (2)$$

where $f(t) = (1,t,t^2,...,t^p)$, $g(t,T_b^c) = l(t > T_b^c)\left\{1, t-T_b^c, (t-T_b^c)^2, ..., (t-T_b^c)^p\right\}$, $\theta = (\theta_0,\theta_1,...,\theta_p)^{/}$, $\gamma = (\gamma_0,\gamma_1,...,\gamma_p)^{/}$, $A(L) = 1 - a_1L - ... - a_{k+1}L^{k+1}$, and $l(.)$ is the indicator function. The autoregressive polynomial $A(z)$ is assumed to have at most one real valued root on the unit circle and all others strictly outside the unit circle, and the error process $\{e_t\}$ is assumed to be i.i.d. $(0,\sigma_e^2)$ with a finite fourth moment. Under (1) and (2), $\{y_t\}$ is an autoregressive, stationary *or* unit root process around a *p*th-order

[2] There exist several unit root tests that allow structural change in the trend function of a time series. Perron (1989) accounts for structural change in a time series by adding a dummy variable corresponding to a pre-determined break date to the augmented test of Dickey and Fuller (1979). Perron and Vogelsang (1992) endogenize the break date for non-trending data. Bai (1997) and Bai and Perron (1998) propose a technique that enables one to estimate breaks either simultaneously or sequentially in cases of non-trending and regime-wise stationary data. Zivot and Andrew (1992) suggest a test for a unit root that allows for a one-time change in the constant and/or in the slope of the trend function of the series. We quote these methods because they are important contributions to the applied research. However, we want to clarify that these tests are removed from the focus of this paper, which is the search for a structural change in the trend function. Thus the unit root question is irrelevant.

deterministic time trend with a break at date T_b^c. The null hypothesis of a stable trend function is given by $H_0 : \gamma = 0$. Under the alternative, at least one of the trend polynomials has a break, $H_1 : \gamma_i \neq 0$ for at least one $i = 0,1,..., p$.

Vogelsang (1997) further shows that using $A(L)$ and the ADF factorization, (1) can be rewritten as

$$\Delta y_t = f(t)\beta + g(t,T_b^c)\delta + d(t,T_b^c)\eta + \pi y_{t-1} + \sum_{i-1}^{k} c_i \Delta y_{t-i} + e_t \qquad (3)$$

where $d(t,T_b^c) = \{l(t = T_b^c + 1), l(t = T_b^c + 1),..., l(t = T_b^c + k)\}, \eta = (\eta_1, \eta_2,..., \eta_k)^{/}$, and β, δ, and η are implicitly defined by $f(t)\beta = A(L) f(t)\vartheta$ and $g(t,T_b^c)\delta + d(t,T_b^c)\eta = A(L) g(t,T_b^c)\gamma$.

Because the one-time dummy variables $d(t,T_b^c)$ are asymptotically negligible, it may be optional to eliminate them.[4] Then, under the null hypothesis of no structural change $H_0 : \gamma = 0$, it directly follows that $\delta = 0$. Therefore, test statistics can be constructed by estimating (3) and testing the hypothesis that $\delta = 0$.

Vogelsang (1997) shows that when the errors of the time series really have a unit root, the power of the test can be improved by conducting a test in first differences. Since the process of first differences of exchange rate is nontrending, the test in our analysis consists of sequentially estimating the following equation:

$$\Delta X_t = \alpha + \theta DU_t + \sum_{j=1}^{k} c_j \Delta X_{t-j} + \varepsilon_t \qquad (4)$$

where X_t is the natural log of nominal exchange rate. The dummy variable for the structural break bears the following values: $DU_t = 1$ if $t > T_B$ and *0* otherwise.

Writing the model in a form given by (4) is useful because the serial correlation in the errors is handled by including enough lags of ΔX_t. The appropriate number of lagged differences (*k*) in equation (4) is determined using the parametric method proposed by Campbell and Perron (1991) and Ng and Perron (1995). An upper bound of the number of lagged differences k_{max} is initially set at an appropriate level. The regression is estimated and the significance (at 10%) of the coefficient c_j is determined. If the

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[3] The procedure does not impose any parametric specifications of distribution. The existence of the fourth moment is a standard assumption for a certain asymptotic parameter and the specification of a wide class of distributions is ensured.

[4] See Vogelsang (1997).

coefficient is not found to be significant, then k is reduced by one and the equation (4) is reestimated. This procedure is repeated with a diminishing number of lagged differences until the coefficient is found to be significant. If no coefficient is found to be significant in conjunction with the respective k, then k = 0.

In our analysis the equation (4) is estimated sequentially for each break period with 15% trimming, i.e., for $0.15T<T_B<0.85T$ where T is the number of observations. The 15% trimming was preferred to that of 1% trimming because it has greater power to detect a break near the middle of the sample. For our model the SupF_t is the maximum, over all possible trend breaks, of the standard F-statistics for testing $\theta = 0$. Thus the break dates are determined endogenously with no *ex ante* preference given to any particular period. The test allows for only a single break in each series.[5] The no-trend break null is rejected in favor of the broken-trend alternative if the SupF_t statistic is greater than the appropriate critical value. We use the critical values for stationary series tabulated by Vogelsang (1997).

3. Data

The study uses data from the following eleven countries: the Czech Republic, Hungary, Poland, Slovakia, Slovenia, Albania, Bulgaria, Romania, Estonia, Latvia, and Lithuania. The time span of the data is from January 1991 to December 1999. The monthly average exchange rates of respective national currencies were obtained from the International Monetary Fund's International Financial Statistics, the Bank for International Settlements, and the EBRD. The reports of the national banks of each country in question were consulted as well. Figures 1 – 11 illustrate the evolution of nominal exchange rates during the researched period.

Table 1 summarizes the basic statistics, average and standard deviation, of the nominal exchange rate for both the US dollar and Deutsche mark. Standard deviations reveal a remarkably high volatility of the national currencies of Romania and Bulgaria. This is in sharp contrast to the other countries, specifically the Baltic states and part of Central Europe. It is also evident that without exception the standard deviation is lower for the exchange rates of the Deutsche mark. The mark has gained in stability over time through the Exchange Rate Mechanism and it has been less volatile than the US dollar. Because

[5] Tests that allow for multiple breaks, such as those devised by Bai and Perron (1998) have only been developed for stationary and non-trending data.

the majority of CEE currencies were, during the researched period, under regimes that were in various ways bound to the Deutsche mark, we suppose that this is the reason for the "transferred" lower volatility in the exchange rates in question.

From the very beginning of the transition process in Central and Eastern Europe, exchange rate behavior and associated exchange rate regimes were closely monitored. The choice of a particular exchange rate regime is one of the major policy decisions transition countries had to make.[6] Exchange rate regimes and the evolution of nominal exchange rates relative to major currencies differ widely across these countries. The Czech Republic and Slovakia favored the semi-fixed regime of a basket peg, while Hungary moved from an adjustable peg to a pre-announced crawling band in 1995, and Poland moved from a fixed basket peg to a crawling basket peg. Many other countries in the region favored a managed float or a currency board. Table 2 summarizes the types of exchange rate regimes that the CEE countries have adopted since their economic transition. Since Table 2 offers merely a sketch of variations in exchange rate regimes, the annual reports of national banks of the CEE countries provide the most complete data. The other specific measures adopted by monetary authorities that may influence the trend behavior of the exchange rate in a particular country and period are specified in the next section.

4. Empirical findings

Before we present our empirical findings, which are summarized in Table 3, several issues should be raised to help interpret the results. As we mentioned in Section 2, the test is able to detect structural change within the time series data without having imposed restrictions on the detrending or stationarity of errors. In the construction of the test it is important to note that, for example, not every peak within the data could be labeled as dramatic point of a change. Firstly, to indicate a structural change, the magnitude of such a peak would have to be enormous. Secondly, even a quite high peak within the data does not need to coincide with a point when a true structural break occurs.

On the other hand several large peaks occurring within a short period of time may increase volatility but they do not necessarily cause structural change. Structural change itself is not related to magnitude of volatility. However, in such a case the test is less

[6] For further discussion see Edison and Melvin (1990), Edwards (1993), Quirk (1994), Begg (1996), and Sachs (1996), among others.

likely to detect a structural break because high volatility or variance lowers the power of the test to detect a structural change in the data.

When commenting on our results we had to describe the economic situation in a particular country. The extent of this description depends on various aspects of the economic environment, including elements of monetary policy that were deemed essential for understanding the presence or absence of structural breaks.

The main outcome of the analysis comparing and contrasting results across countries is that we were frequently able to reject the null hypothesis of no structural break and numerous detected breaks could be associated with policy measures adopted at the same time. However, in several cases we were not able to associate the trend break with a coinciding policy measure that would have a sufficient impact on the exchange rate, its regime, or the foreign exchange market environment.

In the countries that were troubled by unfavorable economic and/or political development the results pointed in favor of policy steps that directly affected the exchange rate. The date at which such a policy measure was adopted corresponded to the date when a structural change occurred. On other hand in some instances of relatively stable transition economies the relevant policy step was implemented several periods after the structural change occurred. In such cases we have suggested economic reasons that might have caused a shift in the exchange rate evolution. Under such circumstances, the policy step only acknowledged the break that already occurred. Yet another group of results are those detected trend breaks that could be caused only by external forces. We now present results for each country separately.

4.1. Central European Countries

In the case of the Czech Republic the test revealed a structural change in January-February 1997. Mounting economic difficulties together with a steady real appreciation of the currency put pressure on the exchange rate, which had been under a currency basket peg regime for several years. Since January 1997 the national currency koruna (CZK) had been depreciating and moving towards the limit of the fluctuation band. The Czech National Bank started to intervene, but eventually freed the exchange rate in late May of 1997. The financial crisis then erupted, straining the banking sector and the economy. The policy step of letting the koruna float was merely an acknowledgement of the structural change that had already happened.

Two breaks were detected at different dates in the case of Slovakia. The first one was detected for the Deutsche mark denominated exchange rate in July 1993. It coincides with a major policy step that occurred at the beginning of July 1993 when Slovakia devalued its national currency, the Slovak koruna (SKK), by 10%. This move happened at a time when the nation's foreign exchange reserves were quite low, about 1.33 billion USD. The National Bank of Slovakia denied that the state of the reserves was the main reason for its move and justified the devaluation by the gap between the amount of money in circulation and the demand for it and by an attempt to encourage exports. The second break occurred in May 1998 for the US dollar denominated exchange rate. The economic problems prompted the first signs of the Slovak koruna's instability as early as January 1998 but *re*lat*ive* stability prevailed during the first half of the year. Preceding the parliamentary elections the market perceived the change in the exchange rate regime as unlikely. Then, the market sentiment altered, accepting the view that the exchange regime had to be changed irrespective of the election result. Confronted with a marked fall in foreign exchange reserves and persistent fears of currency devaluation the National Bank of Slovakia replaced the currency basket peg regime with the float in early October 1998. This situation closely resembles that which occurred in the Czech Republic. The policy step of letting the koruna float was only taken in response to the structural change which had already happened and which did not have entirely institutional origin.

In the case of Hungary, breaks were detected at different dates for both major currencies. The dates are September 1992 for the exchange rate denominated in US dollar and April 1994 for that in Deutsche mark. From 1990 to 1993 a system of adjustable exchange rate fixing was adopted to control the exchange rate of the Hungarian national currency, the forint (HUF). It was basically an adjustable currency basket peg which, until December 1991, included currencies most relevant to foreign trade related payments. At that time the basket consisted of 50% ECU and 50% US dollar. In August 1993 the ECU was replaced by the Deutsche mark, but the weights did not change. In order to better reflect the foreign exchange composition of Hungarian trade the weights were changed in May 1994 so that the basket consisted of 70% Deutsche mark and 30% US dollar. The break in April 1994 for the Deutsche mark denominated exchange rate could be associated with the policy step affecting the basket composition (more weight towards the mark) that was accompanied by devaluation of

the forint by a total of 16.8% in seven steps.[7] The break in September 1992 for the exchange rate denominated in US dollar may have had a different cause. Since the fall of 1992 the exports trend begun to deteriorate and recovered only in 1994. In the fourth quarter of 1992 the forint started to appreciate as a result of the weakening Deutsche mark combined with changes in the gross exchange rates on international foreign exchange markets. Thus the reason for the break is likely to have originated elsewhere than in the policy measure.

The test did not reveal any breaks in the trend behavior of the Polish zloty (PLN). The National Bank of Poland has adjusted the choice of exchange rate regime quite frequently and did not allow for any major real appreciation. The Polish zloty has continuously depreciated over the time without any abrupt swings that would lead to a change in its trend.

In the case of Slovenia the trend break materialized in April-May 1992. Slovenia held a superior position within the former Yugoslav economy. The country had a large foreign trade surplus and its relative international productivity ratios were superior to those in the rest of the former Yugoslavia. In the final years of the former Yugoslavia, inflation had been very high (up to 20% per month) and exchange rate policies were erratic. Thus Slovenia's primary goal was to bring down inflation. The Bank of Slovenia chose the managed float exchange regime as an instrument to achieve this goal. The national currency, the tolar, was introduced on October 8, 1991. The initial disinflation was accomplished successfully and price growth was brought down to 5-6% a month by April 1992 and reached 2% in July. Thus the break essentially marked the end of the period when the exchange policy was used to disinflate the economy. From the middle of 1992 the tolar entered a phase of continuous moderate depreciation within a managed float exchange regime. The regime has an inclination towards the Deutsche mark and the volatility of the US dollar denominated exchange rate is thus greater.

4.2. Balkan Countries

Serious structural breaks were found in the group of Balkan countries that includes Albania, Bulgaria, and Romania. In the case of Albania a trend break materialized in June 1992. The break date coincides with the time when the Albanian national currency, the

[7] About a third (4.6%) of the total devaluation occurred between January and May; a single one-step, 8% devaluation occurred in early August.

lek (ALL), entered a managed float regime and was subject to a 100% devaluation in July 1992. Such a radical step in monetary policy fully explains the materialization of a break in trend behavior of the exchange rate.

In the case of Bulgaria the break was recorded in February 1997. Throughout the transition years both the political and economic situation in Bulgaria worsened. The political crisis of early 1997 combined with an extremely thin foreign exchange market forced the Bulgarian National Bank to alter its method of daily foreign exchange rate fixing to better reflect the market situation. This step was followed by rapid sixfold devaluation of the national currency, the leva (BGL). The massive devaluation of the leva (about 460%) peaked in February 1997, at the time of the detected break. Afterwards, the political crisis was resolved and the exchange rate stabilized at the level of 1500 BGL/USD. Later the currency began to gradually depreciate, reaching a level of 1700 BGL/USD by the middle of year when a currency board was introduced. This change in the exchange rate regime was in line with a new trend underlying the exchange rate and thus did not affect it.

In the case of Romania the test indicated a break in October-November1996. The break was due to the strained economic development that followed the liberalization of the foreign exchange market at the end of 1996. During the first half of 1997, the Romanian currency leu (ROL) dramatically depreciated (nearly 100%) following the administrative measure applied to the foreign exchange market.

4.3. Baltic Countries

A series of events belonging to an overall monetary reform paired with alterations of the exchange rate regime form the complex environment that affected the trend behavior of exchange rates in the group of Baltic states (Estonia, Latvia, and Lithuania).

The Bank of Estonia implemented monetary reform in June 1992, which included a move to a currency board exchange rate regime. Throughout the post-reform period the Estonian kroon was pegged to the Deutsche mark. By virtue of this a break could not occur in the trend function of the exchange rate of the kroon denominated in the Deutsche mark. Thus, the break in November 1996, recorded for the kroon in terms of the US dollar must have been associated with the beginning of the gradual appreciation of the US currency since the fall of 1996. The US dollar gained 7% against the Deutsche mark in 1996, and 14% against it in 1997. The increase is consistent with stronger

economic growth in the US compared to that in Germany and continental Europe. The accelerated appreciation coincides with the detected break date above.

In the case of Lithuania the break occurred in June 1993 for the US dollar and in December 1996 for the Deutsche mark denominated exchange rate. Despite the time difference these dates make sense. After detaching itself from the former Soviet Union, Lithuania introduced a temporary currency, the talona, in May 1992.[8] Monetary reform was implemented in 1993 and the Bank of Lithuania introduced the new national currency, the lita (LTL), in June 1993. After the reform the Bank of Lithuania started to demonstrate its abilities in coping with inflation and the lita was stable during the subsequent months. Then in April 1994 a currency board exchange regime was introduced under which the lita was tied to the US dollar and no break could occur after that. The break in June 1993 can be associated with the re-introduction of the national currency combined with a monetary policy ensuring the stability of the exchange rate. The break in December 1996 recorded for the lita in terms of the Deutsche mark has a purely economic reason. It is associated with the beginning of the gradual depreciation of the German currency with respect to the US dollar since the fall of 1996. This situation mirrors that of Estonia.

In the case of Latvia the test revealed a break in February 1993. The country experienced hyperinflation in 1992, and underwent a monetary reform, which involved abandoning the Russian rouble, introducing a temporary currency, the Latvian rouble, and finally reinstating the historical national currency, the lat, in March 1993. We infer that the break in 1993 is related to the introduction of the lat, yet the reason why the statistic of the break was significant only for the national currency lat with respect to US dollar remains a puzzle.[9]

5. Concluding Remarks

In this paper I attempted to analyze the trend behavior of nominal exchange rates of eleven CEE countries. The exchange rates are expressed in terms of the US dollar and the Deutsche mark. The aim of this paper was to provide evidence of the existence or

[8] This step was not paired with a strong monetary commitment and the country experienced hyperinflation during 1992 (1,020.8%) and 1993 (410.2%). The central bank, Bank of Lithuania, introduced the floating exchange rate regime in October 1992 and the talona depreciated considerably against the dollar during the last quarter of 1992 and the first quarter of 1993.

[9] The lat is pegged to the Special Drawing Rights (SDR) basket where the US dollar has the greatest weight, which may explain why the break did not materialize in case of the Deutsche mark rate.

non-existence of structural change in the trend functions of exchange rates series during the transition.

The main outcomes of the analysis are that a) we were frequently able to reject the null hypothesis of no structural break, and b) numerous detected breaks could be associated with policy measures adopted at the same time. However, in several cases we were not able to associate the trend break with a coinciding policy measure that would have a sufficient impact on the exchange rate, its regime, or the foreign exchange market environment.

In Central European countries the exchange rates evolved in a relatively stable manner without extremely volatile periods or extreme depreciation. Poland was the only country where we were not able to reject the null hypothesis of no structural break. Most of the detected structural breaks could be associated with policy steps. However, in the cases of Czech Republic and Slovakia we found that the breaks occurred prior to policy steps aiming to influence the exchange rate evolution. In these instances the policy steps have been an acknowledgement of the structural change that had already happened due to an economic development.

Serious structural breaks were found in the group of Balkan countries that includes Albania, Bulgaria, and Romania. In this group the structural breaks can be decisively associated with policy steps that either affected the exchange rate, its regime, the foreign exchange market environment, or a combination of these. In Albania the structural break was entirely associated with the massive devaluation of the exchange rate and a revision of its regime. In Romania and Bulgaria the break was associated with monetary policy steps related to foreign exchange markets that were accompanied by massive devaluations.

A series of events belonging to overall monetary reforms paired with alterations of exchange rate regime formed the complex environment that affected the trend behavior of the exchange rates in the group of Baltic states (Estonia, Latvia, and Lithuania). These countries freed themselves from the former Soviet Union and within the scope of monetary reforms re-introduced their national currencies. The structural breaks detected were associated mainly with the re-introduction of national currencies and adoption of tight exchange rate regimes. Those countries that pegged their currencies to the US dollar or the Deutsche mark experienced a trend break in the exchange rate denominated in a currency other than that of the peg. Such a finding is consistent with world

macroeconomic development as it is associated with the gradual appreciation of the US dollar against the Deutsche mark since the fall of 1996.

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Table 1
Basic Statistics of Nominal Exchange Rates

Country	**US Dollar: mean (st.dev.)**	**Deutsche Mark: mean (st.dev.)**
Czech republic	28.72 (1.93)	18.02 (0.52)
Slovak republic	30.65 (1.92)	19.25 (1.13)
Hungary	116.56 (38.97)	73.32 (23.99)
Poland	2.13 (0.73)	1.34 (0.46)
Slovenia	109.17 (41.01)	68.74 (25.33)
Bulgaria	292.68 (590.62)	172.42 (338.51)
Romania	2154.97 (2303.06)	1332.07 (1335.60)
Albania	102.78 (25.98)	64.67 (14.09)
Estonia	12.64 (0.91)	7.97 (0.11)
Latvia	0.60 (0.08)	0.38 (0.05)
Lithuania	3.83 (0.68)	2.43 (0.46)

Table 2
Exchange Rate Regimes

Country	**Regime**
Czech Republic	Fixed (basket peg) since January 1991 to May 1997 Float from May 1997
Hungary	Adjustable peg (basket peg) since before 1989 Pre-announced crawling band (peg) since March 1995
Poland	Fixed (basket peg) from January 1990 to October 1991 Pre-announced crawling peg from October 1991 to May 1995 Float within crawling band from May 1995 to January 1996 Pre-announced crawling peg from January 1996
Slovakia	Fixed (basket peg) since January 1991 Float from October 1998
Slovenia	Managed float from October 1991
Albania	Managed float from July 1992
Bulgaria	Managed float from February 1991 Currency board from July 1997
Romania	Managed float from August 1992
Estonia	Currency board from June 1992
Latvia	Managed float from July 1992 (in reality peg to SDR basket)
Lithuania	Float from October 1992 to April 1994 Currency board from April 1994

Table 3
SupF for Nominal Exchange Rates in Terms of the US Dollar and Deutsche Mark

Currency	**SupF-stat for USD**	**Lag**	**Time**	**SupF-stat for DEM**	**Lag**	**Time**
Czech Koruna	13.56***	2	Jan-97	8.65*	7	Feb-97
Hungarian Forint	8.23*	3	Sep-92	12.01**	5	Apr-94
Polish Zloty	7.02	6	Feb-94	6.30	7	Jul-93
Slovak Koruna	8.32*	2	May-98	9.07*	2	Jul-93
Slovenian Tolar	9.47*	4	Apr-92	11.35**	8	May-92
Albanian Lek	14.85***	1	Jun-92	29.96***	1	Jun-92
Bulgarian Leva	41.31***	2	Feb-97	40.58***	2	Feb-97
Romanian Leu	11.19**	8	Nov-96	10.18*	8	Oct-96
Estonian Kroon	8.50*	2	Nov-96	1.30	5	Jan-97
Latvian Lat	33.38***	7	Feb-93	5.43	7	Feb-93
Lithuanian Lita	33.43***	7	Jun-93	16.74***	7	Dec-96

Note: ***, **, and * denote significance at 1% (13.02), 5% (10.69) and 10% (7.32) levels.

Figure 1

Exchange Rate of Czech *koruna* per USD and DEM

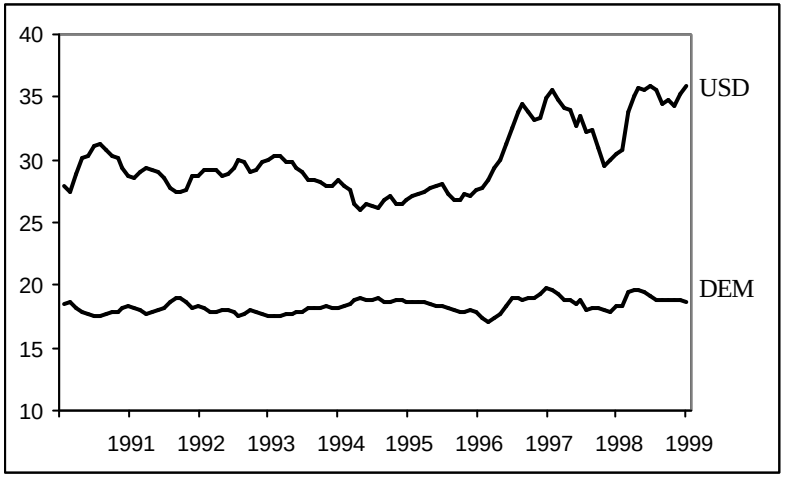

Figure 2

Exchange Rate of Slovak *koruna* per USD and DEM

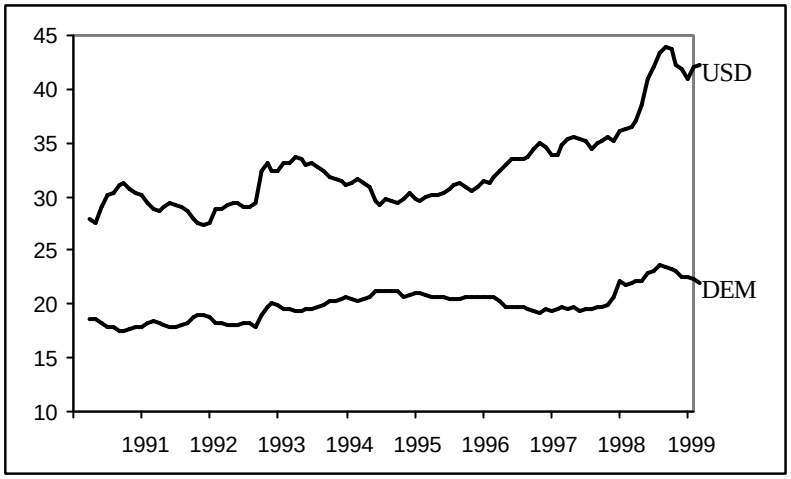

Figure 3

Exchange Rate of Polish *zloty* per USD and DEM

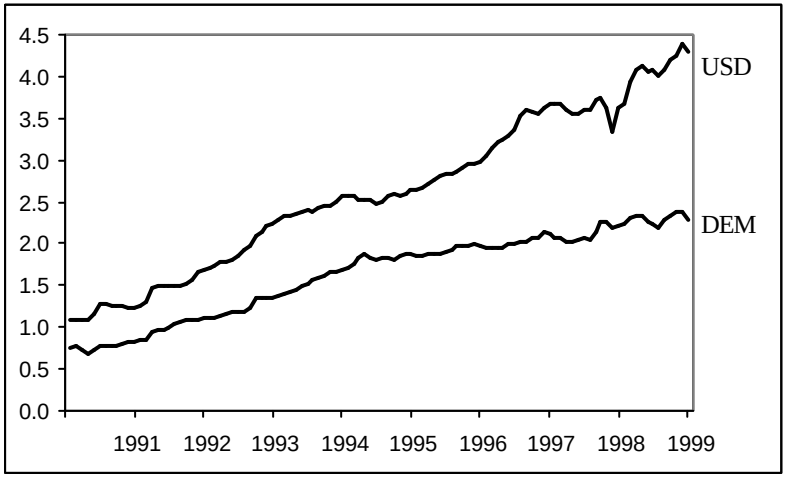

Figure 4

Exchange Rate of Hungarian *forint* per USD and DEM

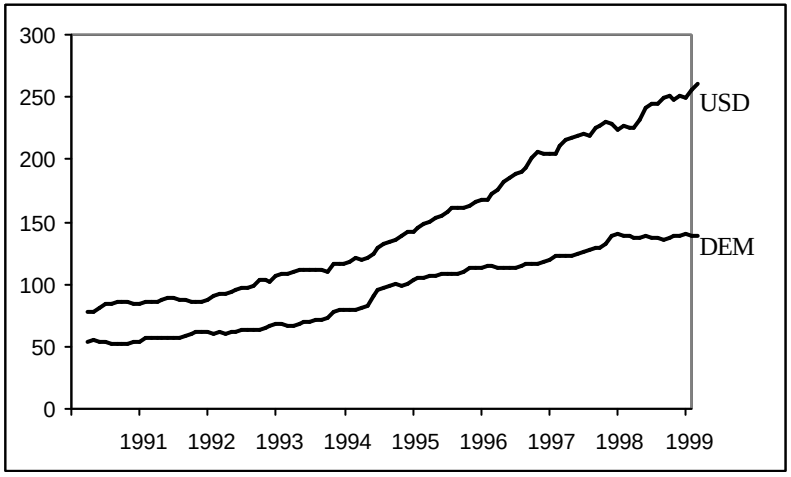

Figure 5
Exchange Rate of Slovenian *tolar* per USD and DEM

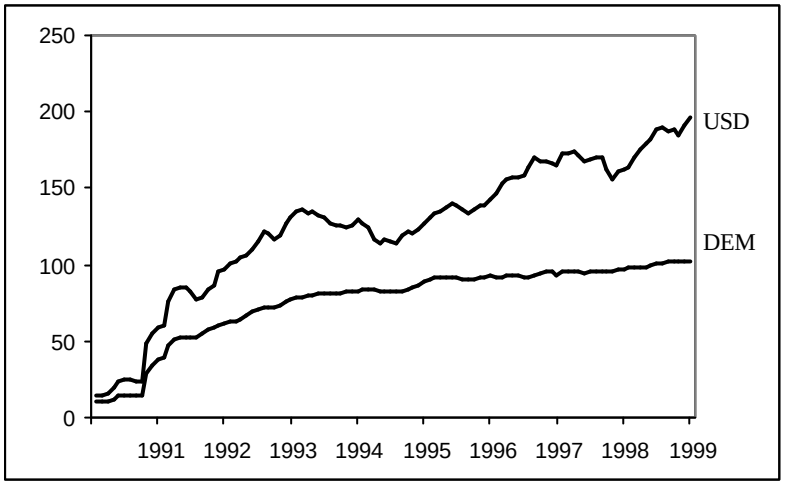

Figure 6
Exchange Rate of Romanian *leu* per USD and DEM

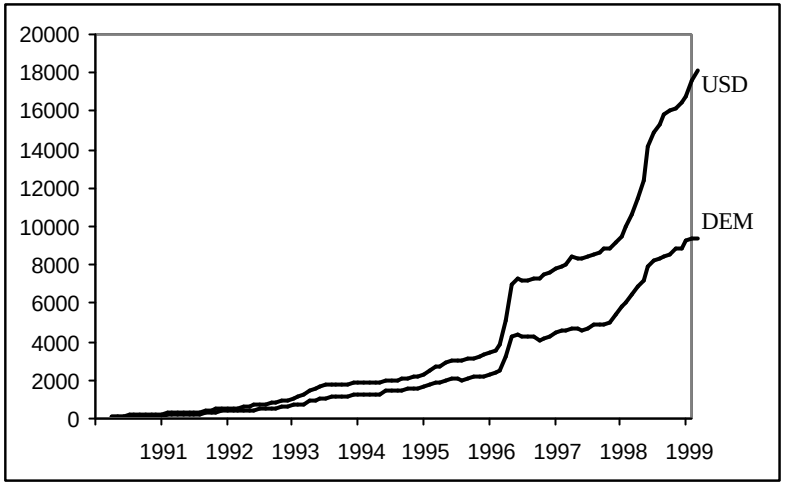

Figure 7
Exchange Rate of Bulgarian *leva* per USD and DEM

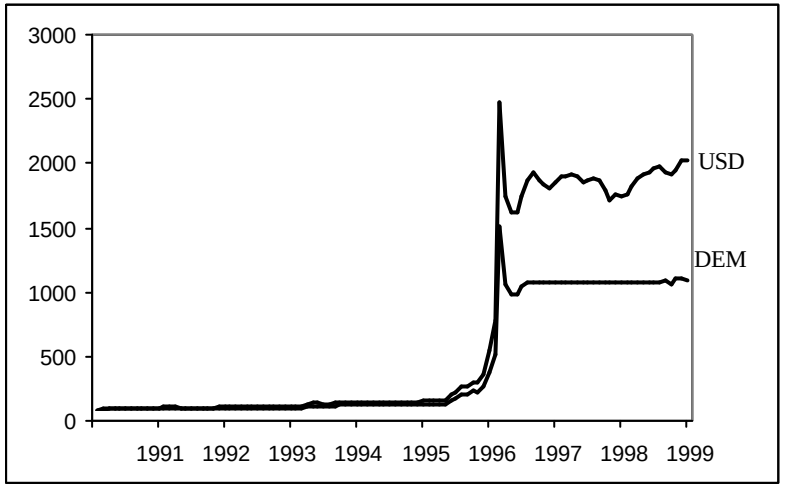

Figure 8
Exchange Rate of Albanian *lek* per USD and DEM

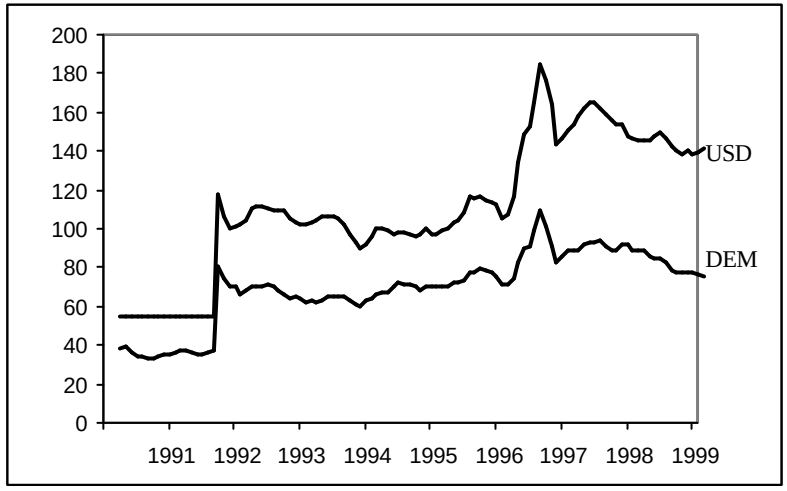

Figure 9
Exchange Rate of Estonian *kroon* per USD and DEM

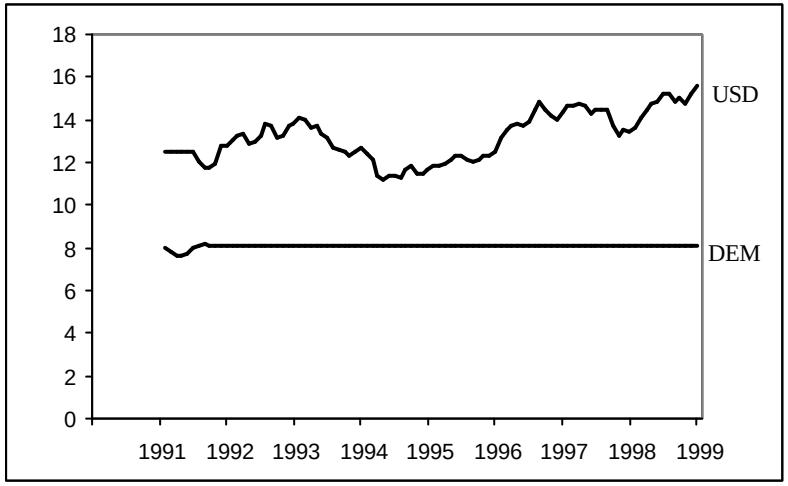

Figure 10
Exchange Rate of Lithuanian *lita* per USD and DEM

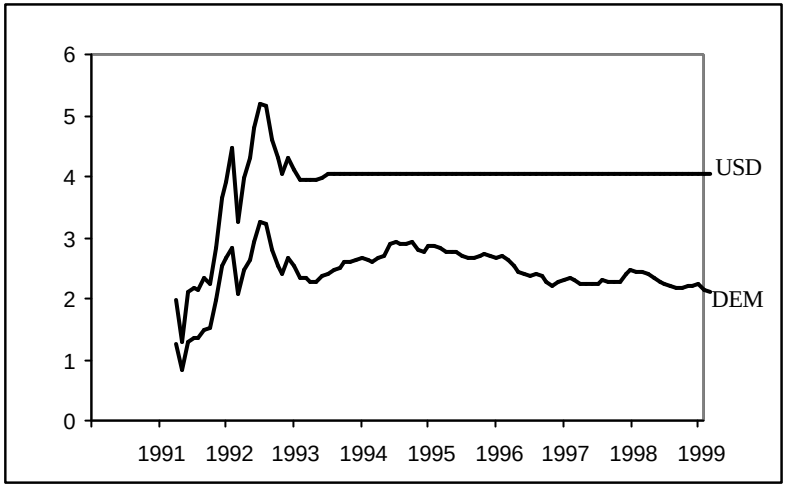

Figure 11
Exchange Rate of Latvian *lat* per USD and DEM